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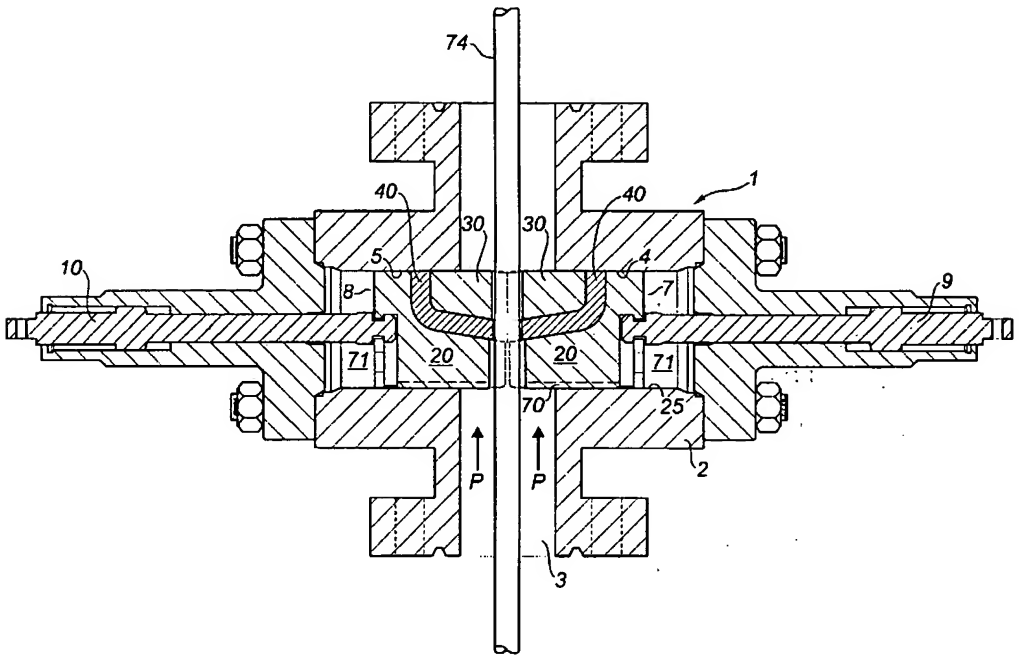
(54) **MACHOIRE DE BLOC OBTURATEUR DE TETE DE PUITS**
(54) **WELLHEAD PRODUCTION BLOWOUT PREVENTER RAM**



(57) The ram comprises an L-shaped bottom retainer plate, an L-shaped seal element and a top retainer plate having an L-shaped inner surface. The front portions of the inner surfaces of the retainer plates are parallel and acutely angled relative to the longitudinal axis of the ram bore. Thus the top retainer plate is tapered rearwardly. The seal element protrudes forwardly of the retainer plate which, in turn, protrudes forwardly of the bottom retainer plate. When the rams close, the top retainer plates are driven rearwardly and act as wedges to compress the seal elements both downwardly and rearwardly. The L-shaped design also leads to minimization of canting of the plates. A groove is provided, extending longitudinally along the base of the bottom retainer plate, for draining steam condensate from behind the ram.

"WELLHEAD PRODUCTION BLOWOUT PREVENTER RAM"

ABSTRACT OF THE DISCLOSURE

The ram comprises an L-shaped bottom retainer plate, an L-shaped seal element and a top retainer plate having an L-shaped inner surface. The front portions of the inner surfaces of the retainer plates are parallel and acutely angled relative to the longitudinal axis of the ram bore. Thus the top retainer plate is tapered rearwardly. The seal element protrudes forwardly of the retainer plate which, in turn, protrudes forwardly of the bottom retainer plate. When the rams close, the top retainer plates are driven rearwardly and act as wedges to compress the seal elements both downwardly and rearwardly. The L-shaped design also leads to minimization of canting of the plates. A groove is provided, extending longitudinally along the base of the bottom retainer plate, for draining steam condensate from behind the ram.

TECHNICAL FIELD

This invention relates to the rams used in a wellhead production blowout preventer.

BACKGROUND ART

The invention has to do with improving the rams in a known oilfield wellhead assembly component known as a high temperature production blowout preventer (hereafter "BOP").

This type of BOP is commonly used in connection with thermal pumping wells. With such wells, a sucker rod string is reciprocated or rotated to drive a downhole pump, which lifts the produced fluid to the surface through a tubing string in the course of the production cycle. The well is also used to inject steam in the course of the steaming cycle.

The BOP is equipped with rams that can be advanced horizontally to seal around the vertical polish rod of the rod string, to prevent the upward escape of fluid.

More particularly, the BOP comprises a cross-shaped housing forming a vertical bore and a pair of coaxial, horizontal ram bores intersecting the vertical bore from each side. The BOP is commonly positioned in the wellhead assembly between the tubing head and the flow tee. The BOP vertical bore therefore forms part of the wellhead assembly fluid passageway.

A ram is positioned in each ram bore. Each ram usually comprises a cylindrical back plate, a top retainer plate, a bottom retainer plate and a T-shaped seal element sandwiched between the plates. The components are held together by cap screws. The assembly is illustrated in prior art Figures 1 – 2.

As stated, the ram bores extend into or join with the vertical bore. The bore surfaces combine at their intersection to form sealing areas. A screw jack or like means is used to apply mechanical force to each ram back plate to advance the rams toward each other into sealing engagement. The inner end faces of the retainer plates and the seal element each form a semi-circular, vertically-directed groove. Thus, when the polish rod of the rod string is present in the vertical bore and the rams are closed, the ram ends encircle and press against it to effect a seal. At the same time, the seal element is compressed by the retainer plates pushing back against the back plate, thereby effecting an axial seal along the two sides of each ram and a circumferential seal. The pressure in that portion of the wellhead assembly fluid passageway below the rams is prevented from reaching that portion of the passageway above the rams.

There are problems associated with the rams just described.

Firstly, when the two rams are pressed together, the protruding seal elements contact first and act to spread the front ends of the retainer plates. The retainer plates begin to cant and can become jammed. The rams then are difficult to withdraw.

Secondly, during steaming, steam can get behind the rams and, in cold weather, can condense and freeze. The BOP may then be impossible to operate and it becomes necessary to bring a steam truck to the site to heat the wellhead and thaw the ice. This is expensive and time-consuming to do.

It is therefore one objective of the invention to alter the design of the ram so that its tendency to get jammed is reduced or eliminated. It is another objective to modify the ram so that steam condensate behind the ram can escape back into the wellhead to reduce or prevent the build-up of ice behind the ram.

It is also an objective of the invention to improve the life of the seal. The key difference that achieves this is the way force is applied to the seal element. In the prior art, force is applied to the seal only from the front face. The seal element is forced upward and downward to meet the retainer plates. The seal is typically manufactured from laminated sheets of asbestos or graphite and the direction of the laminations are parallel to the ram bore. The force on the seal element works to expand the seal and separate the seal laminanted sheets. The invention has been designed to compress the seal element in a way that will reduce delamination.

SUMMARY OF THE INVENTION

The invention is directed to a wellhead production BOP ram, having front and rear ends, and comprises:

- substituting a generally L-shaped retainer plate for the prior art bottom and back plates (this retainer plate hereafter being referred to as the "rear retainer plate");
- adopting a generally L-shaped configuration for the seal element;
- forming the other retainer plate (referred to as the "front retainer plate") so that its inner surface is also generally L-shaped;

- whereby, when the plates and seal element are assembled with the seal element sandwiched between the inner surfaces of the plates, they form a full bore body which conforms to the surface of the ram bore;
- acutely angling, relative to the axis of the bore, at least one of the front portions of the retainer plate inner surfaces so that, when the front plate is driven rearwardly, there is both radial and axial compression of the seal element arising from a wedging action. In a preferred embodiment, the front retainer plate is on the top and the rear retainer plate is on the bottom and the front portions of their inner surfaces are parallel and upwardly inclined relative to the axis of the bore;
- staggering the vertical alignment of the front end surfaces of the components so that those of the front retainer plate and seal element protrude beyond that of the rear retainer plate. Preferably the front end of the seal element protrudes beyond the front end of the front retainer plate which, in turn, protrudes beyond the front end of the rear retainer plate; and
- preferably orienting the front and rear retainer plates at top and bottom of the ram, respectively, and forming the bottom of the outer longitudinal surface of the rear retainer plate to provide a longitudinally extending groove for draining steam condensate, from behind the ram, back into the wellhead.

By modifying the ram in this manner, the following advantages are obtained:

- the L-shaped design ensures that the rear retainer plate is rigidly supported around its circumference at its rear end by the BOP housing and this rigidity extends to the front portion of the retainer plate, so that the latter will not cant downwardly when extended into the vertical bore of the BOP and pressed against the polish rod. In addition, the rear retainer plate now provides a rigid anvil against which the front retainer plate may downwardly and rearwardly compress the seal element, thereby attaining a good longitudinal seal and reducing the likelihood that the front retainer plate will cant;
- in addition, the L-shaped design extends to the seal element which means that the seal does not extend to the base of rear retainer plate,, making it possible for the drainage groove to extend along the bottom surface of the plate;
- the angling of one or more of the front portions of the inner surfaces, coupled with the front end protrusion of the front retainer plate relative to that of the rear retainer plate, also leads to a desired wedging effect which assists in reducing canting of the front retainer plate and assists in improved seal element compression; and

- with the new design, as the ram assembly is advanced, wedging of the two retainer plates acts to force the laminated sheets together and keep the seal element compressed, thus extending the life of the seal. This shape also allows the use of very brittle materials that will fail under any loading but compression.

DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded perspective view of a prior art ram used in production wellhead BOP's;

Figure 2 is a sectional side view showing the ram of Figure 1 assembled;

Figure 3 is an exploded perspective view showing a ram in accordance with the invention;

Figure 4 is a rear end view of the ram of Figure 3;

Figure 5 is a sectional side view taken along lines A—A and B—B of Figure 4, showing the staggering of the front surfaces and the angling of the front portions of the inner surfaces of the retainer plates; and

Figure 6 is a sectional side view of a BOP having a pair of rams in accordance with the invention, shown in the closed position sealing against the polish rod of a sucker rod string.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Having reference to Figure 6, a production blowout preventer 1 comprises a cross-shaped housing 2 forming a vertical bore 3 and a pair of coaxial horizontal ram bores 4,5. The ram bores 4,5 intersect with the vertical bore 3 and form sealing areas.

A pair of generally cylindrical rams 7,8 are located within the ram bore 4,5. Screw jacks 9,10 extend through plugs 11,12 threaded into the outer ends of the ram bores 4,5. The screw jacks 9,10 can be turned to advance or retract the rams 7,8 into or out of the vertical bore 3.

Each of the cylindrical rams 7, 8 comprises a generally L-shaped, rear retainer plate 20 having an arcuate longitudinal outer surface 21 and an L-shaped inner surface 22 having front and rear portions 23, 24. The outer surface 21 conforms with the cylindrical surface 25 of the ram bore in which it is positioned. The rear retainer plate therefore has a close sliding fit in the ram bore. A pair of bolt holes 26 extend through the upright, full bore diameter section 27 of the rear retainer plate 20. In the embodiment shown, each rear retainer plate 20 is positioned at the base of the ram of which it forms a part.

Each ram 7,8 further comprises a front retainer plate 30. The plate 30 has an arcuate, longitudinal outer surface 31 and a generally L-shaped inner surface 32. The inner surface 32 has front and rear portions 33,34. A pair of bolt holes 35 extend longitudinally inward from the inner surface rear portion 34.

The retainer plates 20, 30 will normally be formed of steel.

A generally L-shaped seal element 40 is sandwiched between the inner surfaces 32, 22 of the front and rear retainer plates 30, 20. The seal element 40 is formed of material commonly used for this purpose in production BOP rams, such as asbestos or graphite combined with a bonding agent. A pair of bolt holes 41 extend through the upright portion 42 of the seal element 40, in register with the bolt holes 26, 35 of the rear and front retainer plates 20, 30.

The front portions 33, 23 of the inner surfaces 32, 22 are equally acutely angled relative to the longitudinal axis of the ram bores 4,5. Each front retainer plate 30 therefore has a tapered or wedge-like configuration.

The inner and outer surfaces 43, 44 of each seal element 40 conform with the inner surfaces 32, 22 of the retainer plates 30, 20.

A pair of bolts 50 extend through the bolt holes 26, 41 and 35 to tie together the rear retainer plate 20, seal element 40 and front retainer plate 30. This will be visible in Figures 3 – 5. The bolts 50 each have threads 51 on one end and a center section 52 with larger diameter than the threaded end, creating a shoulder 53, at the back end of the hreads. This shoulder 53 contacts a shoulder 54, in the front retainer palte 30, fixing the two pieces together. A separate shoulder 55 at the head of the bolt and a shoulder 56 in the rear retainer plate 20 limit the movement of the front retainer palte 30 forward but allow movement rearwardly a limited amount, in order to compress the seal element 40.

The front faces 60, 61 and 62 of the front retainer plate 30, seal element 40 and rear retainer plate 20, respectively, are staggered; that is the seal element protrudes further forward than the front retainer plate which, in turn, protrudes further forward than the rear retainer plate. Each of the faces 60, 61, 62 forms a central, vertical, semi-circular groove 63 for extending around the rod string polish rod 74.

In operation, the jacks 9, 10 are actuated to bias the rams 7, 8 forwardly toward each other. As the seal elements 40 contact and press against each other or the polish rod, the front retainer plate 30 is pressed rearwardly. As it moves, its inner surface 43 compresses the seal element 40 downwardly and rearwardly against the inner surface 22 of the rear retainer plate 20. The front surfaces 61 seal against each other and the seal element outer surfaces 44 seal against the ram bore surfaces 25, both longitudinally and circumferentially.

In a preferred feature, a longitudinally extending groove 70 is formed in the bottom of the outer surface 21 of each rear retainer plate 20. These grooves 70 connect the spaces 71 behind the rams 7, 8 with the vertical fluid production passageway 72 of the wellhead 73. Condensed steam in the spaces 71 can drain into the passageway 72 to avoid ice build-up.

The assembly has been described with the rams 7, 8 having the rear retainer plate 20 on the bottom. However the rams could be rotated to position the rear retainer plates 20 on top. In addition, only one inner surface front portions 33, 23 needs to be angled to achieve the wedging effect. Furthermore, the rams and ram bores have been described as being cylindrical – however they can be ovalled as well. Finally, the rear retainer

plate has been described as one piece – however it could also be formed in two pieces. These modifications are considered to be within the scope of the invention.

The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment provides the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A ram for use in the bore of a wellhead production blowout preventer to seal around a rod string, said ram having front and rear ends, comprising:

a front retainer plate having an arcuate longitudinal outer surface, for conforming with the bore surface, and a generally L-shaped inner surface comprising front and rear portions;

a generally L-shaped rear retainer plate having an arcuate longitudinal outer surface for conforming with the bore surface, and a generally L-shaped inner surface comprising front and rear portions;

a generally L-shaped seal element adapted to be positioned between the retainer plates so that the retainer plates and seal element will combine to form a full bore body having a longitudinal axis;

means for holding the plates and seal element together, said means being operative to allow the front retainer plate to move rearwardly a limited amount;

the front ends of the front retainer plate and seal element protruding beyond the front end of the rear retainer plate when the ram is assembled and is out of sealing engagement;

at least one of the inner surface front portions being acutely angled relative to the longitudinal axis of the ram;

so that, when the rear retainer plate is biased forwardly to advance the ram into sealing engagement, the front retainer plate is driven rearwardly and compresses the seal element both radially and axially with a wedging action.

2. The ram as set forth in claim 1 wherein the rear retainer plate may be positioned at the bottom of the ram when assembled and the plate's outer surface forms a groove extending longitudinally thereof along its base.

3. The ram as set forth in claim 2 wherein the front end of the seal element protrudes beyond the front end of the front retainer plate which protrudes beyond the front end of the rear retainer plate.

4. The ram as set forth in claims 1, 2 or 3 wherein the front portions of the inner surfaces are both angled and parallel.

5. A production blowout preventer comprising:

a housing forming a vertical bore extending longitudinally therethrough and a pair of coaxial horizontal ram bores, each having a longitudinal axis and a bore surface, extending transversely thereof and intersecting the vertical bore;

a pair of rams positioned in the ram bores, each ram having front and rear ends, the rams being slidable along the ram bores so as to project into the vertical bore where their front ends may seal against a rod string polished rod extending therethrough; and

means for advancing and withdrawing the rams between sealing and open positions;

each ram comprising

a front retainer plate having an arcuate longitudinal outer surface, for conforming with the adjacent ram bore surface, and a generally L-shaped inner surface comprising front and rear portions;

a generally L-shaped seal element positioned between the retainer plates so that the retainer plates and seal element combine to form a full bore body having a longitudinal axis;

means for holding the plates and seal element together, said means being operative to allow the front retainer plate to move rearwardly a limited amount;

the front ends of the front retainer plate and seal element protruding beyond the front end of the rear retainer plate when the ram is out of sealing engagement;

at least one of the inner surface front portions being acutely angled relative to the longitudinal axis of the body;

so that, when the rear retainer plate is biased forwardly to advance the ram into sealing engagement, the front retainer plate is driven rearwardly and compresses the seal element both radially and axially with a wedging action.

6. The ram as set forth in claim 5 wherein the rear retainer plate is positioned at the bottom of the ram and the plate's outer surface forms a groove extending longitudinally thereof along its base, so that steam condensate trapped rearwardly of the ram may escape back into the wellhead through the groove.

7. The ram as set forth in claim 6 wherein the front end of the seal element protrudes beyond the front end of the front retainer plate which protrudes beyond the front end of the rear retainer plate.

8. The ram as set forth in claims 5, 6 or 7 wherein the front portions of the inner surfaces are both angled and parallel.

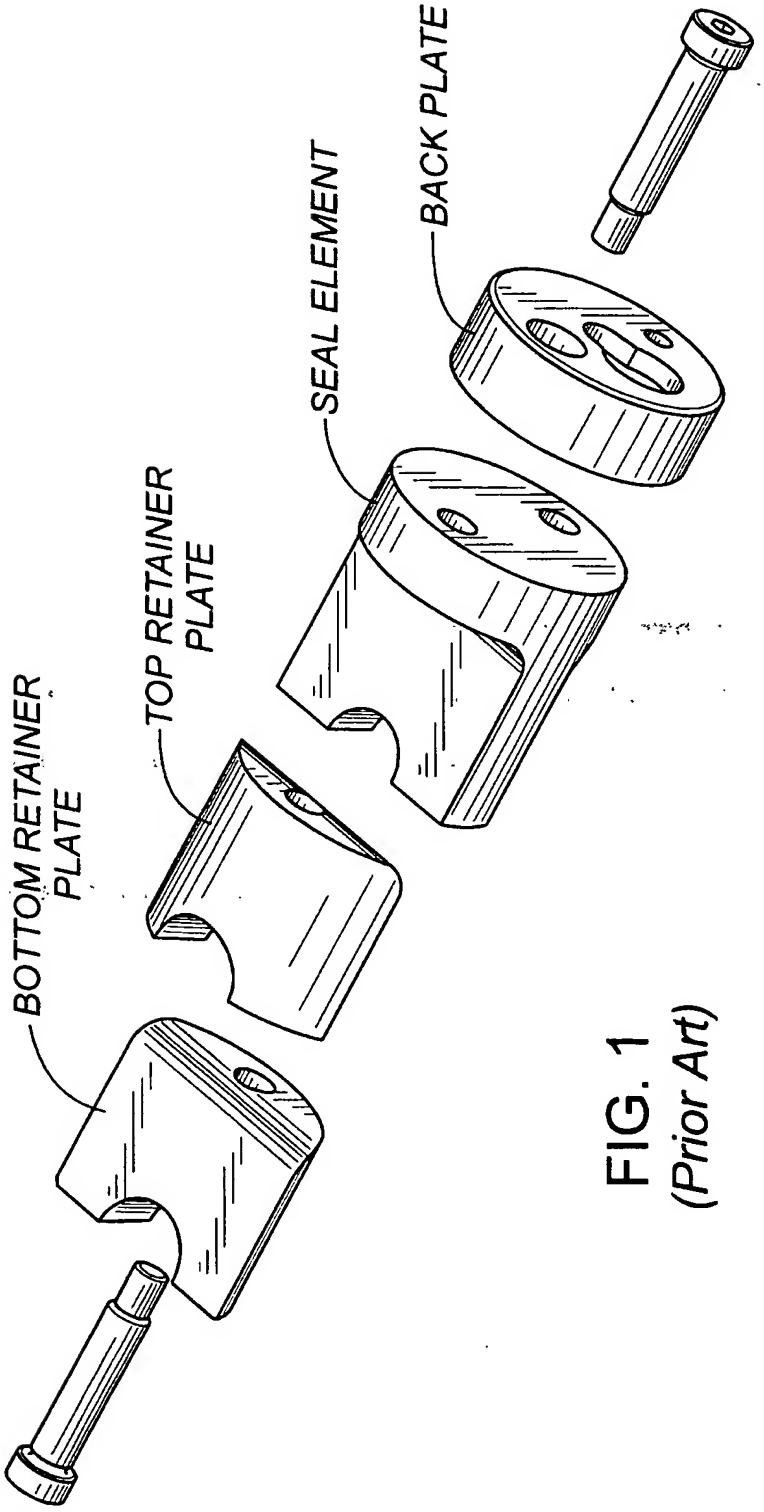


FIG. 1
(Prior Art)

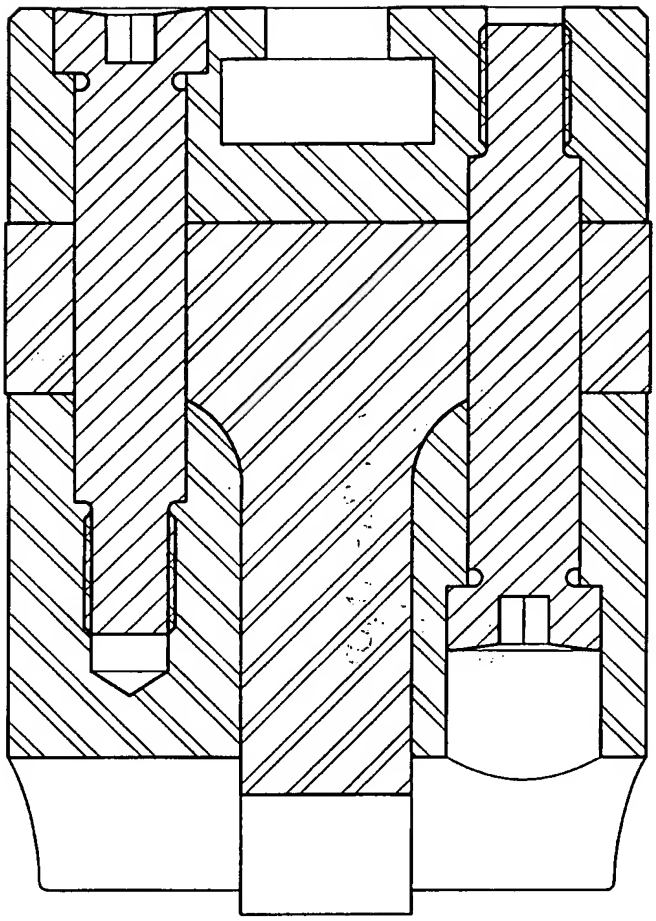


FIG. 2
(Prior Art)

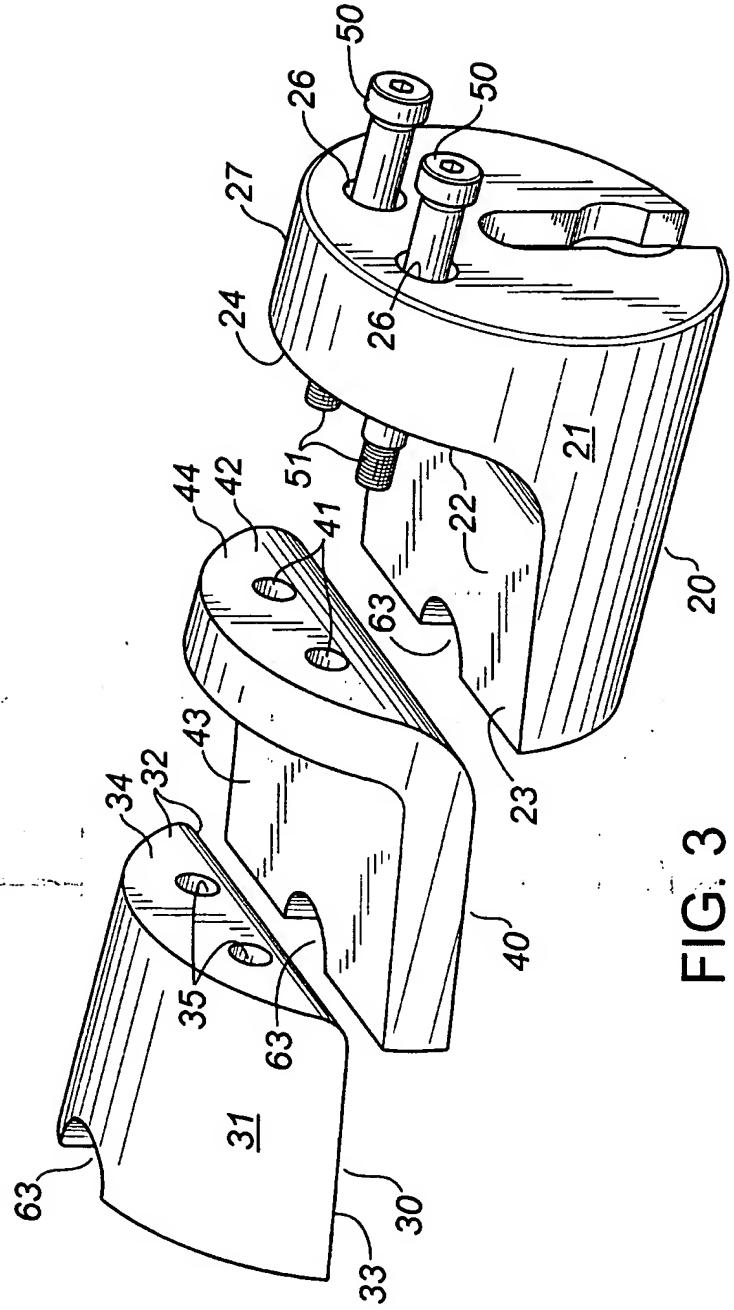

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FIG. 3

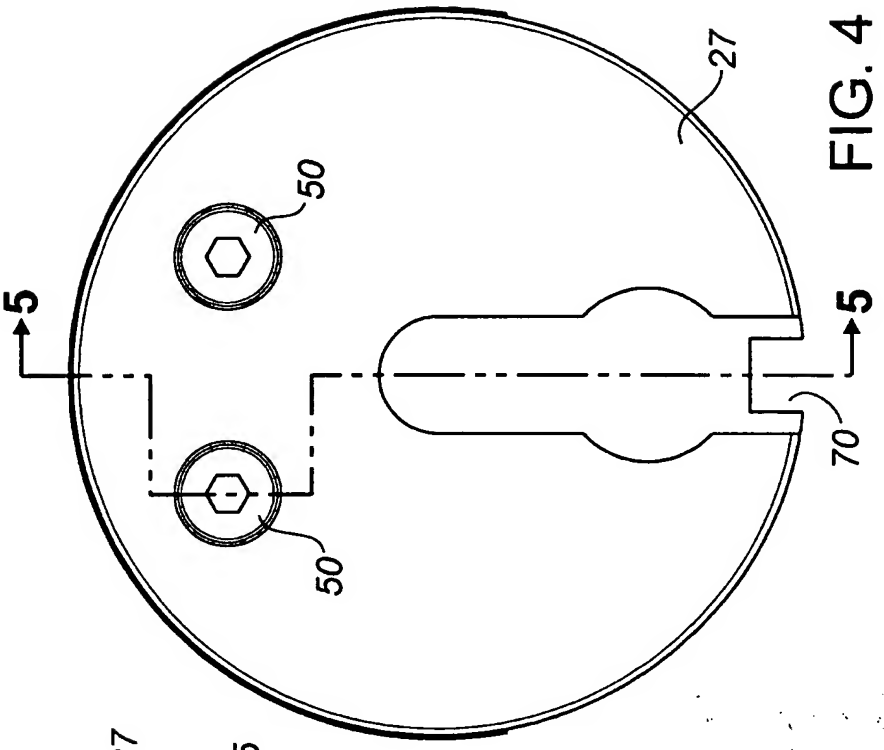
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FIG. 4

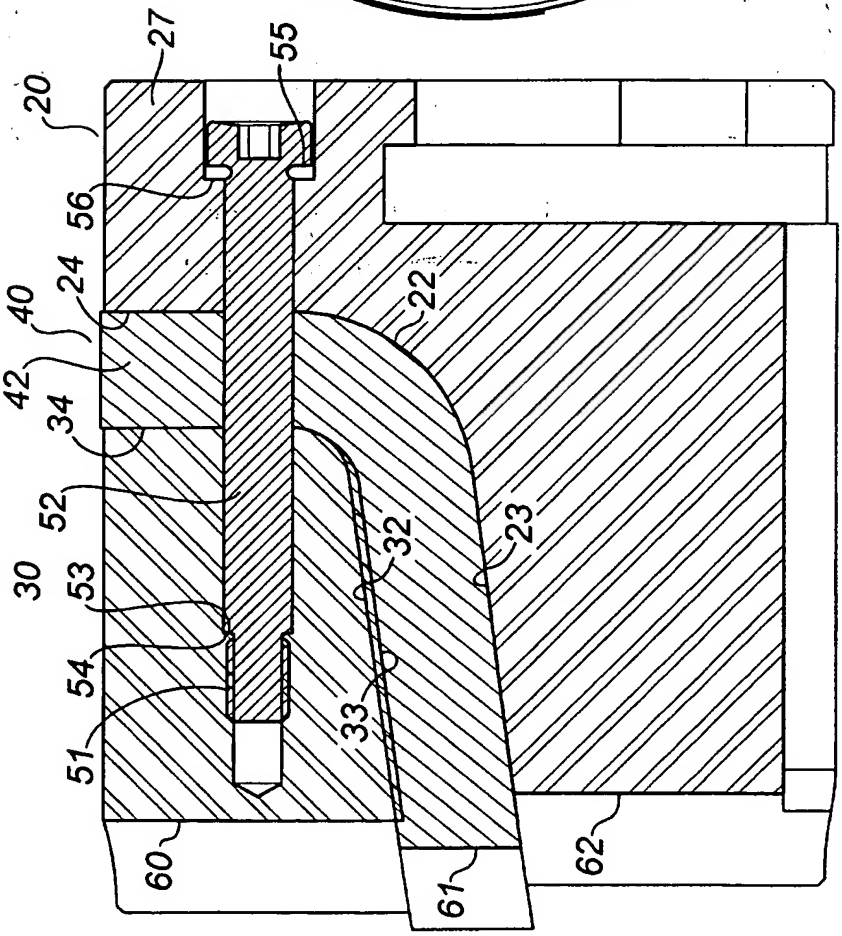
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FIG. 5

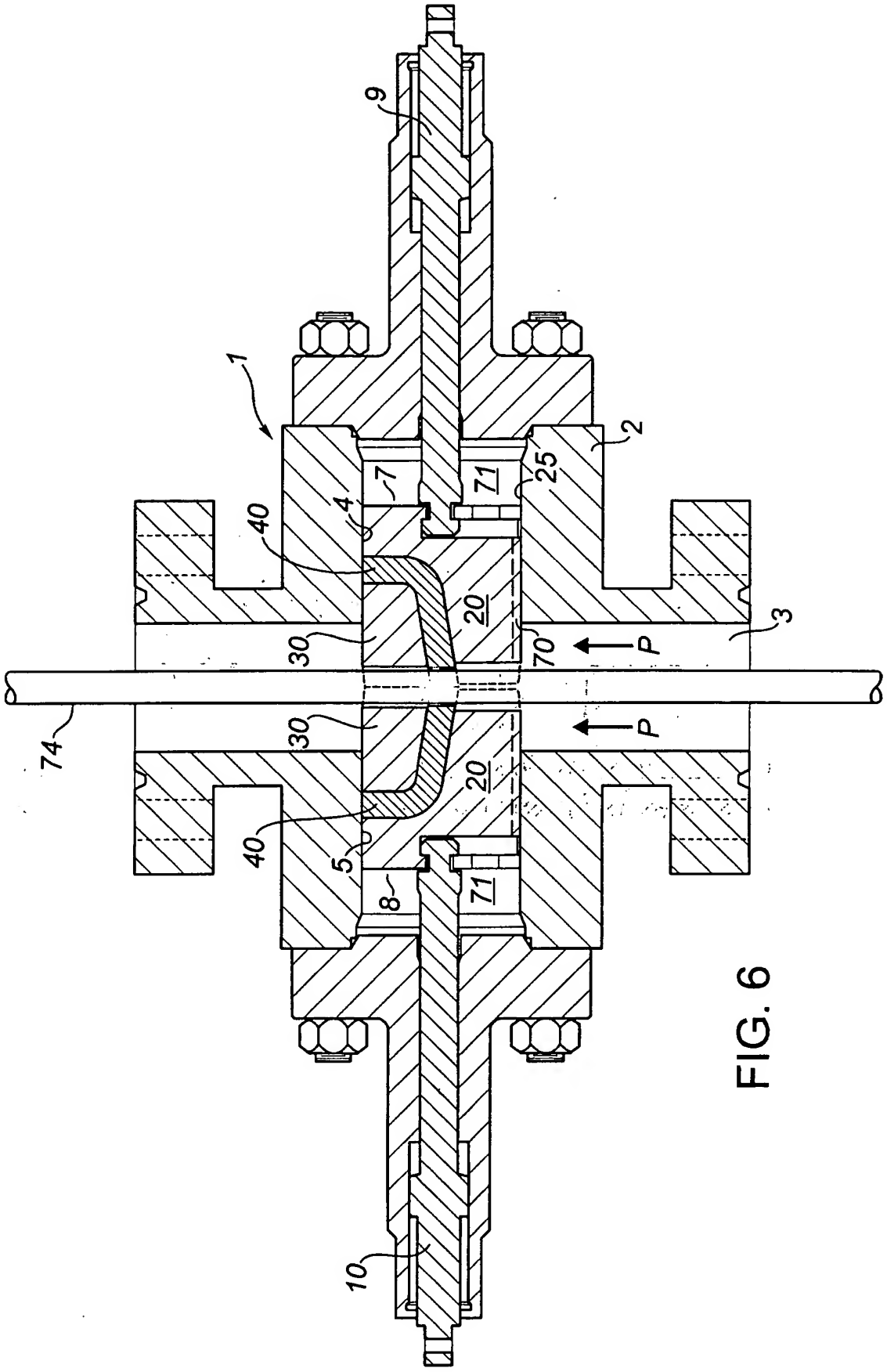
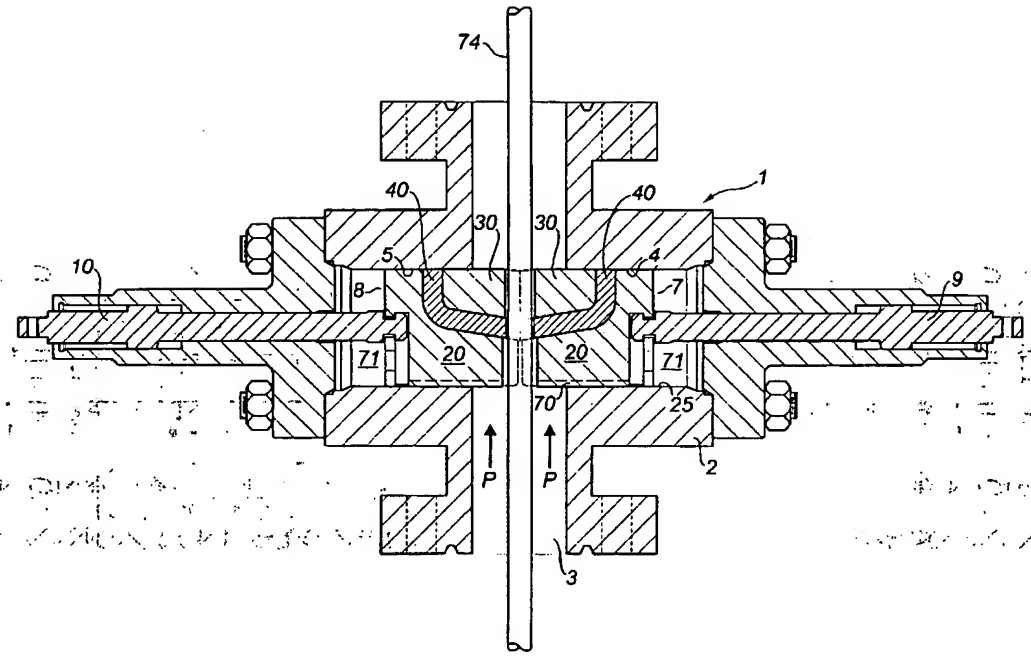


FIG. 6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